China Deep Underground Laboratory and Dark Matter Search

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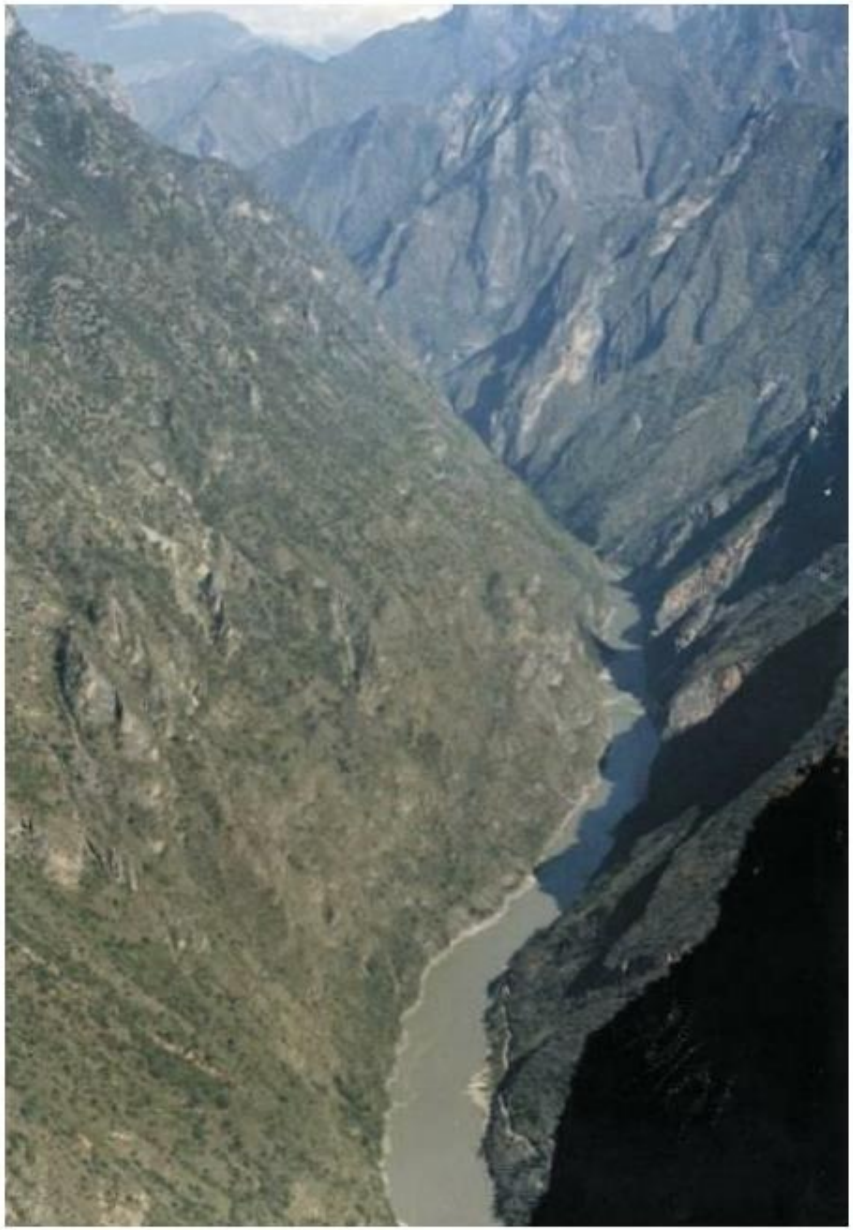
Yalong River and Jingpin Hydropower station

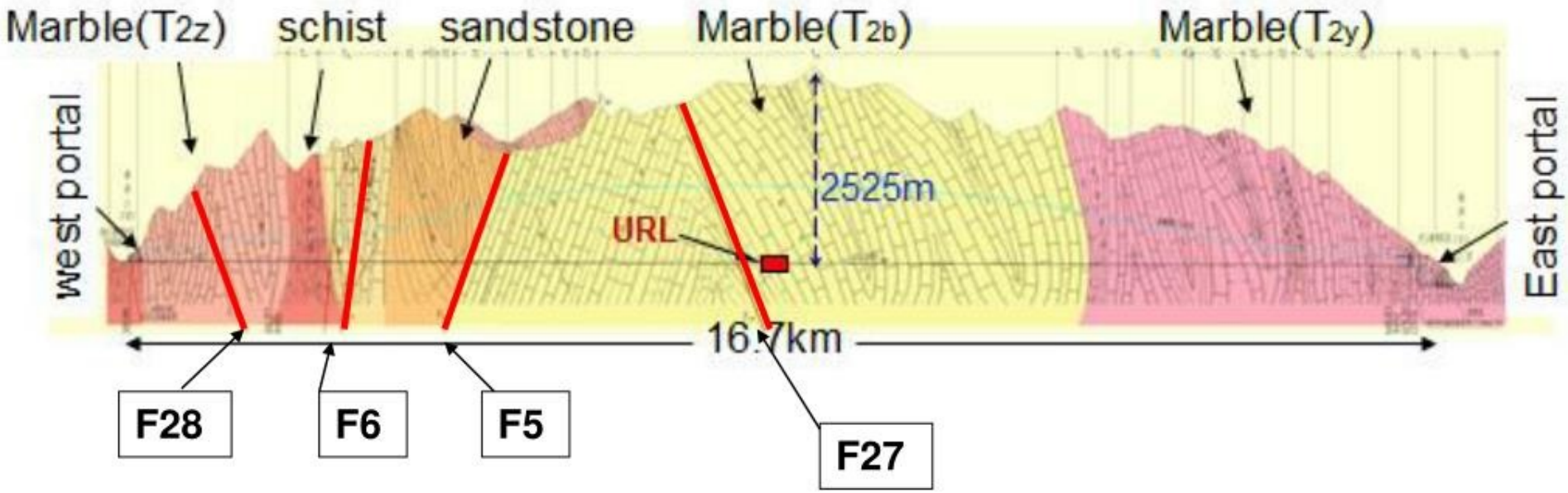
Yalong river locates the west of Sichuan, with length of 1571km and drop height of 4420m. 21 Hydropower stations are planned, with total electricity of 30GW.

Big U-turn at Jingpin mountain

High Mountain and Canyon

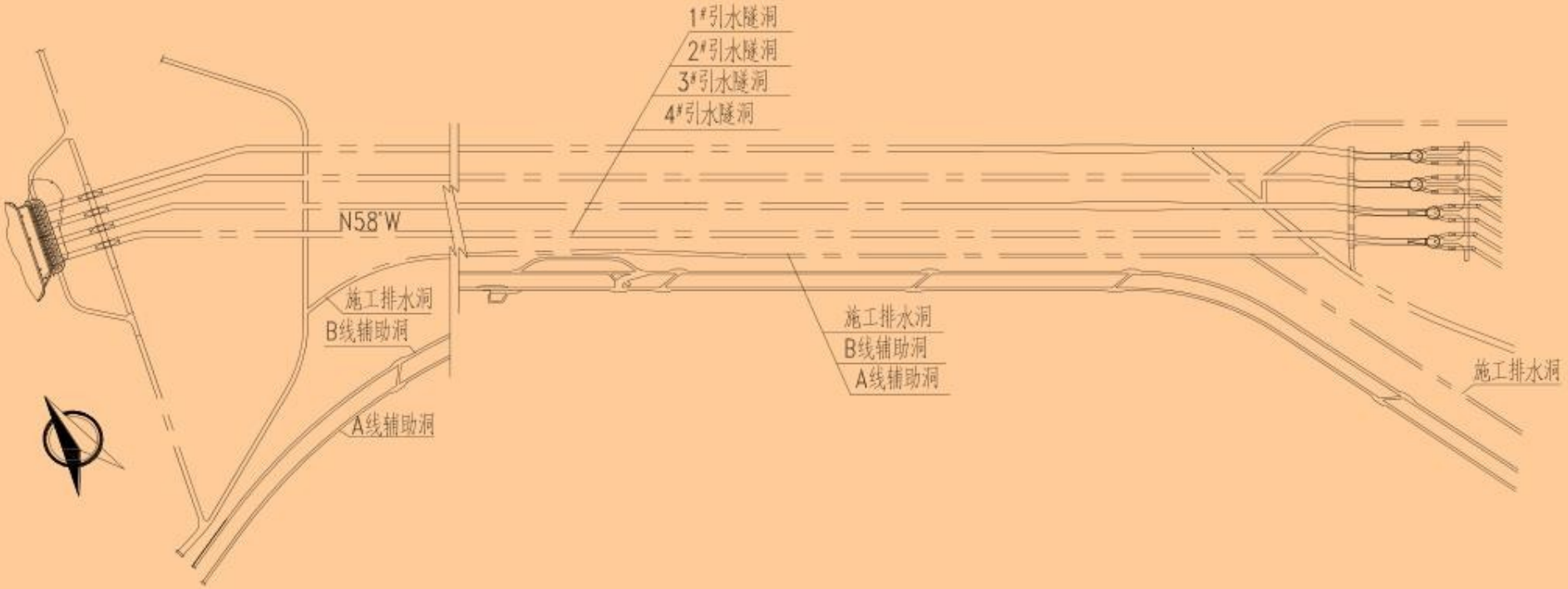


Geological structure of Jingpin



- **The peak of the mountain：4193m**
- **Maximum rock overburden of tunnels ~2525m**
- **Rock cover larger than 1500m >70%**
- **Challenges for tunnel construction**
  - **High geostress: 11.11～ 46.41MPa., Max:70MPa**
  - **Rock burst: mainly right after excavation**
  - **Rich underground water: 5~7m^3/s, pressure 10MPa**

Tunnels at Jingpin Mountain

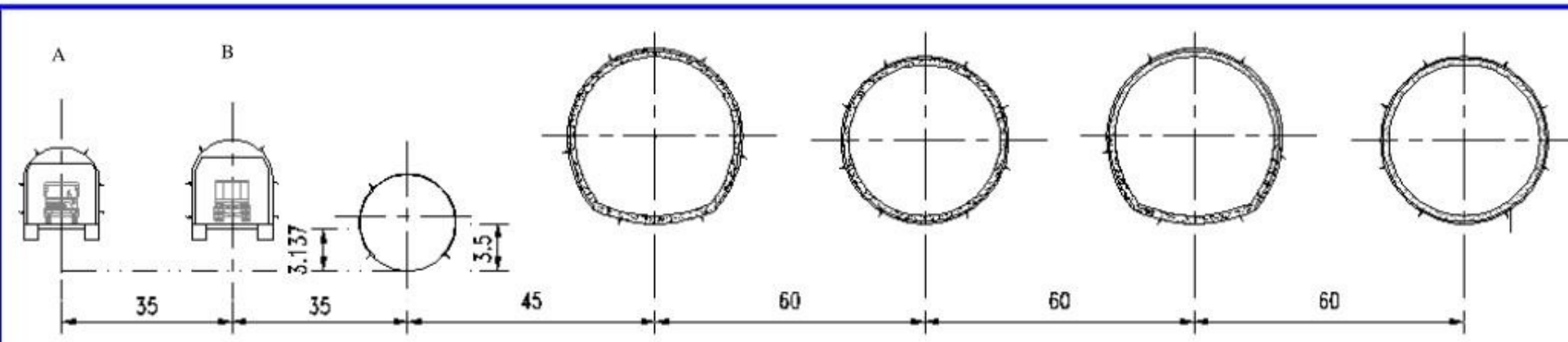


Tunnels at Jingpin Mountain

- Four water tunnels: length of 16.67km
  - two of diameter of 12.4 m: TBM
  - two of diameter of 13m: drilling and blasting,
- Two traffic tunnels: 5.5×5.7m、6×6.25m, length of 17.5km
- One drain tunnel with diameter of 7.2m, length of 17.5km

(only used during construction, and could be used for super big volume experiment!)

- maximum Overburden 2525m



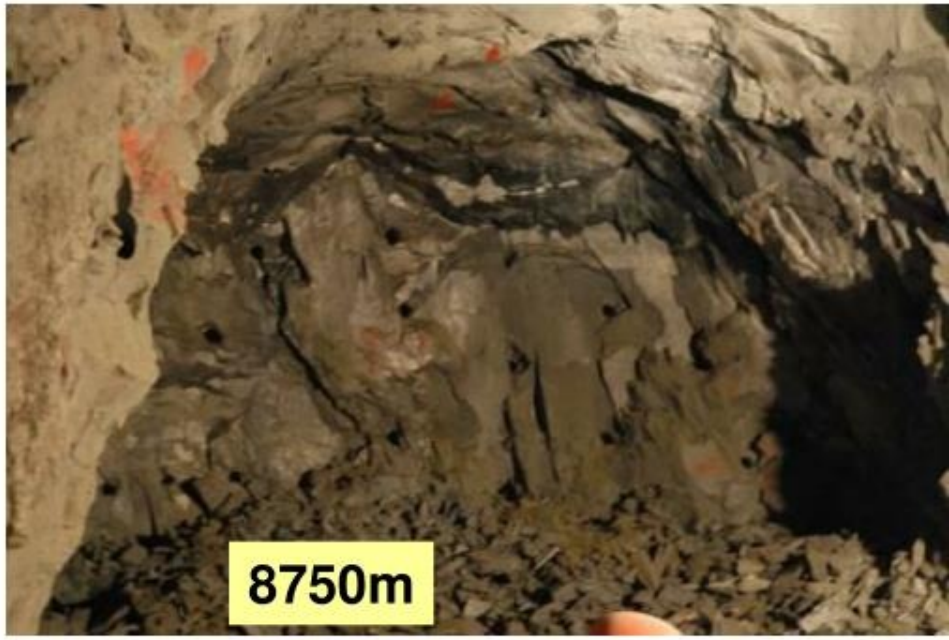
TBM for water tunnels

Both traffic tunnels were run-through Aug. 2008, to be opened by end of this year

Traffic tunnel under construction

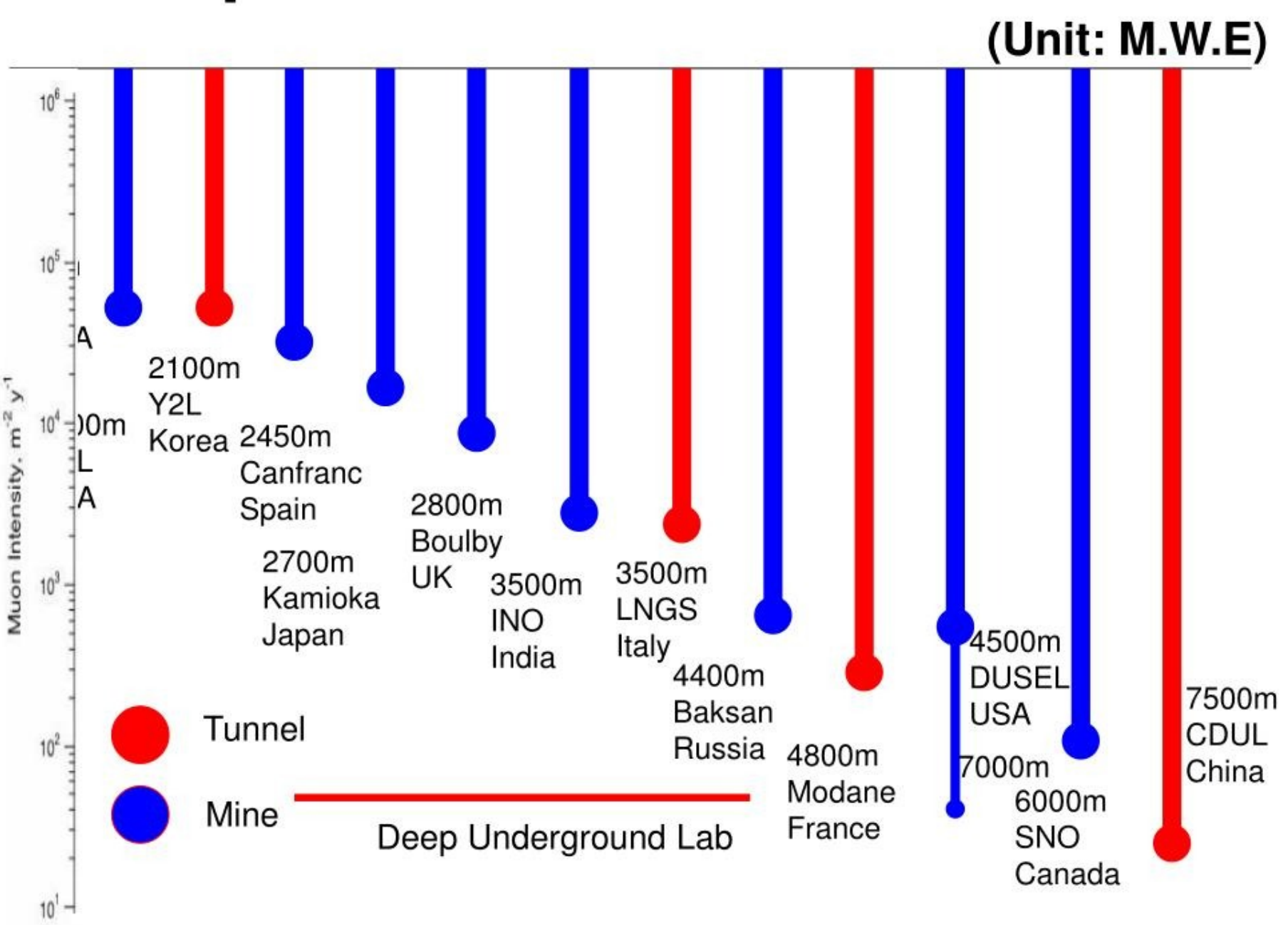
Site visit Feb. 27, 2009

The radioactivity of the rocks from the center of the traffic tunnel (8750 m) is very low.



	K-40 (1460keV)	Ra-226 (609keV)	Th-232 (911keV)
Rock sample from 8750m	< 1.1	1.8±0.2	< 0.27
Surface @ Beijing	600	25	50

Comparison of main UL's in world



Infrastructure available in the hydropower station

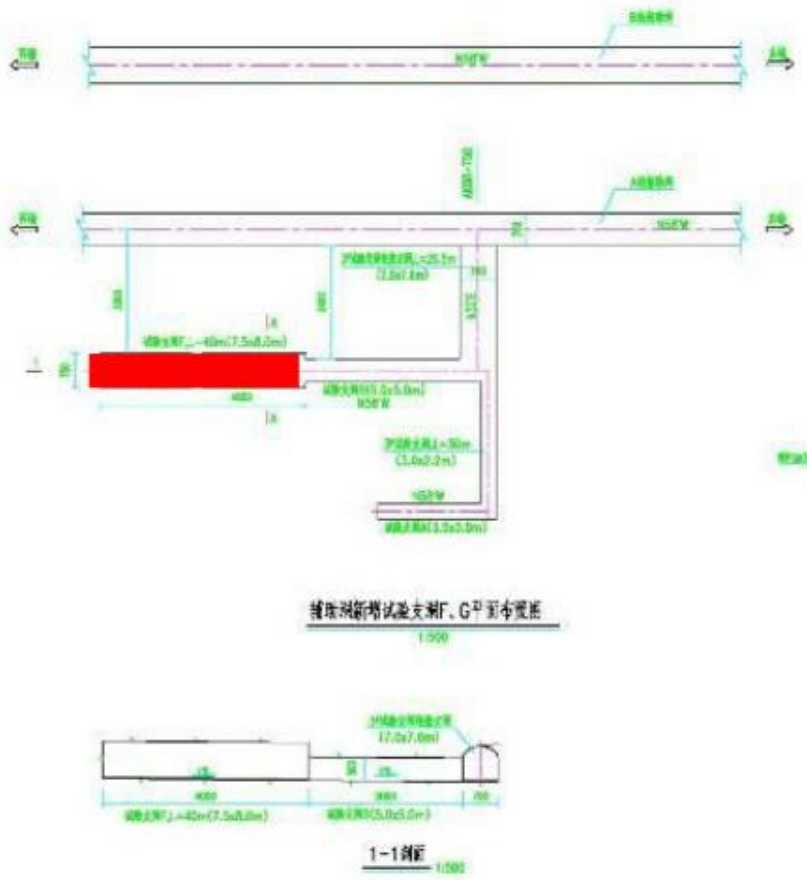
Good motorway to airport: 1.5 hour

Deep Underground Lab. at Jingpin Mountain

- The tunnel group at Jingpin mountain provides an unique opportunity to build a world class deep underground lab for multiple science research.
  - Deepest in the world
  - Horizontal Tunnel access
  - Convenient transportation, good infrastructure
- The best site for the national deep underground science and engineering lab. . Chinese funding agencies could support it.
- The lab. should be international, and opened to World.
- Two small experimental halls near the traffic tunnel B under construction.

Two small exp. halls under construction

6X6X20 m



Fragrant Hill Forum (25-26 Oct.) :

Deep Underground Sciences & Engineering

Participants:

- **Scientists from**
  - **Exp. and theo. physics: particle physics, nuclear physics, astrophysics, gravitation…**
  - **Geo-physics**
  - **Geology**
  - **Rock mechanics**
- **Deep underground engineers**
- **The Owner of the Hydropower station:**
  Ertan Hydropower Development Company (EHDC)
- **Design and construction company**
- **Funding agencies**

Purposes of the Forum

To reach common understanding about

- Importance of deep underground S&E research in China
- Great opportunities in Jingpin mountain tunnel group
- Needs to establish China Deep Underground S&E Lab. (CDUSEL)
- Strategy and Planning for CDUSEL

To convince EHDC

- To support CDUSEL
- To provide the interface for the construction of CDUSEL in near future.

The forum was success

- The above common understanding reached
- Possible initial experiments discussed
- Demand to the CDUSEL design and plan.
- Construction: Staging
- A working group for CDUSEL, including scientists and engineer from major fields and major institutions and Univ., as well as EHDC, established. Chair: Hesheng CHEN.
- Funding agencies (CAS, MoST and NSFC) support the idea of CDUSEL.

EHDC supports the Lab.

- Vice-CEO of EHDC expressed
  - Their understanding and support to CDUSEL.
  - Agree to support the interface for the construction of CDUSEL.
  - Condition: no risk to construction and commissioning of hydropower stations.
  - The approval from the EHDC board needed.

Working on Proposal of CDUSEL

- CDUSEL belongs the catalog of "large fundamental science research facility" in the Chinese funding system.
- The key agency for the national lab. is the state commission of development and reform.
- The funding procedure for CDUSEL will be rather long.

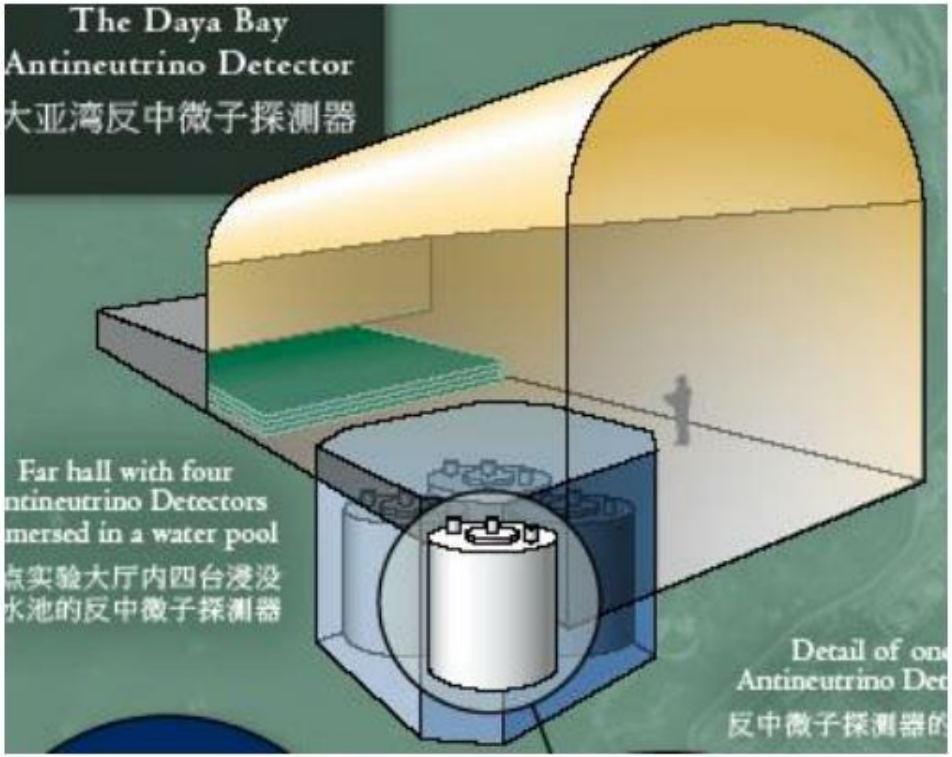
Underground experiments in China

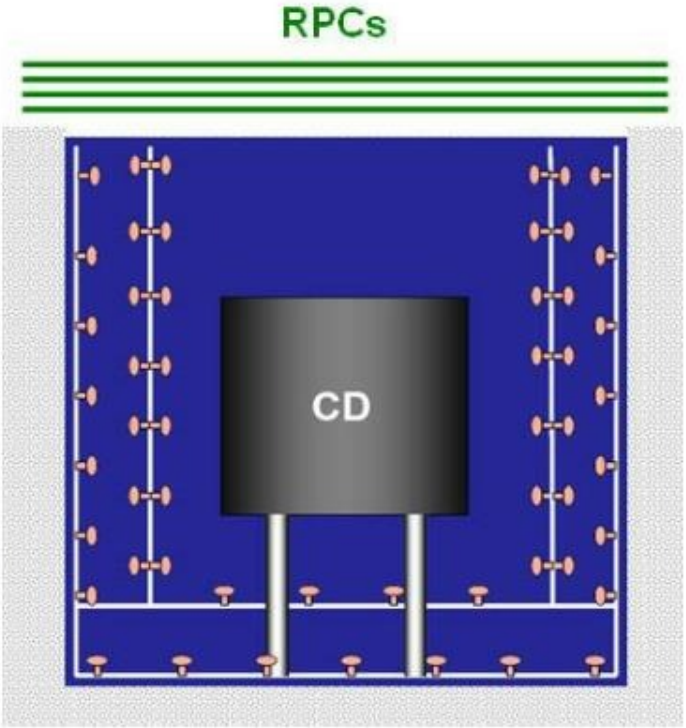
- Underground experiments in China
  - Double β decay (^{44}Ca) in coal mine of Beijing (1986-1990)
  - Dayabay reactor neutrino experiment
- Join International collaborations
  - DAMA at LNGS
  - XENON at LNGS
  - CsI(Tl) crystal detector at KIMS
  - Kamland
  - SuperK
  - …

Daya Bay Reactor Exp.

- Near-far cancellation
- Two near sites and one far sites connected by ~3000 tunnel
- Event rate:
  ~1200/day near
  ~350/day far
- backgrounds:
  B/S ~0.4% near
  B/S ~0.2% far

Detector design: multiple detector modules and multiple VETO





- **Multiple detector modules to reuce errors and cross check**
- **Multiple muon veto:**
  - **Two-layers of cerenkov detector**
  - **RPC at the top**
  - **Total efficiency > (99.5 ± 0.25) %**

Redundancy is a key for the success of this experiment

Lining of access tunnel

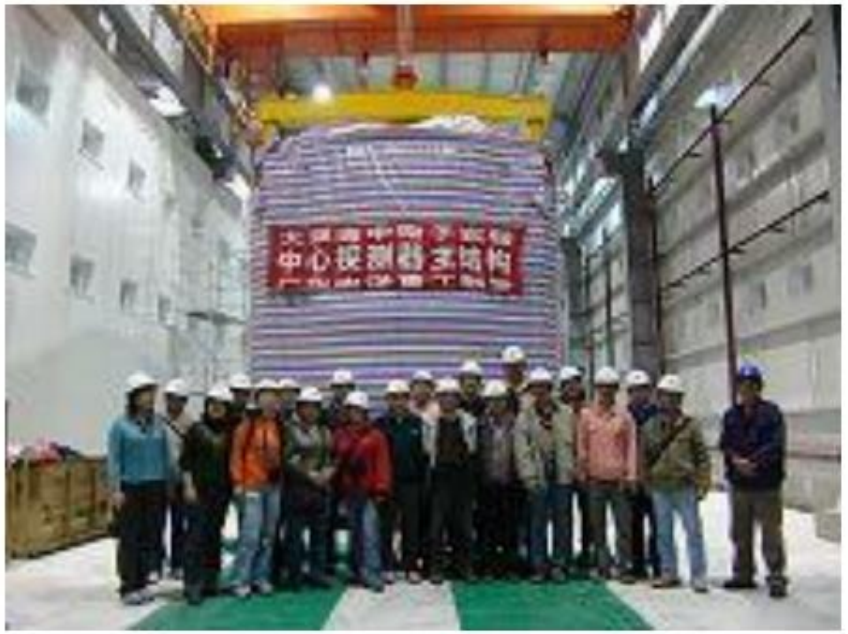
Excavation of EH 1

2009-8-14

Stainless Steel Vessel

1st SSV complete fabrication in Jan.
Full load test, negative pressure test, laser survey, etc. → 1 month

This is the first large item arriving SAB.



Experiment Proposals in Jingpin

Many discussions about the possible experiments for the deep underground lab. at Jingpin.

- **China Dark matter EXperiment (CDEX) by Tsinghua Univ.**
- **XENONIT by Shanhai Jiaotong Univ..**

CDEX Plan

Phase-I (2009.12-2010.12)

-- 20g ULE-HPGe detector @ CDUL
-- Shielding system construction
-- HPGe detector for radioactive measurement
-- Radon monitor system

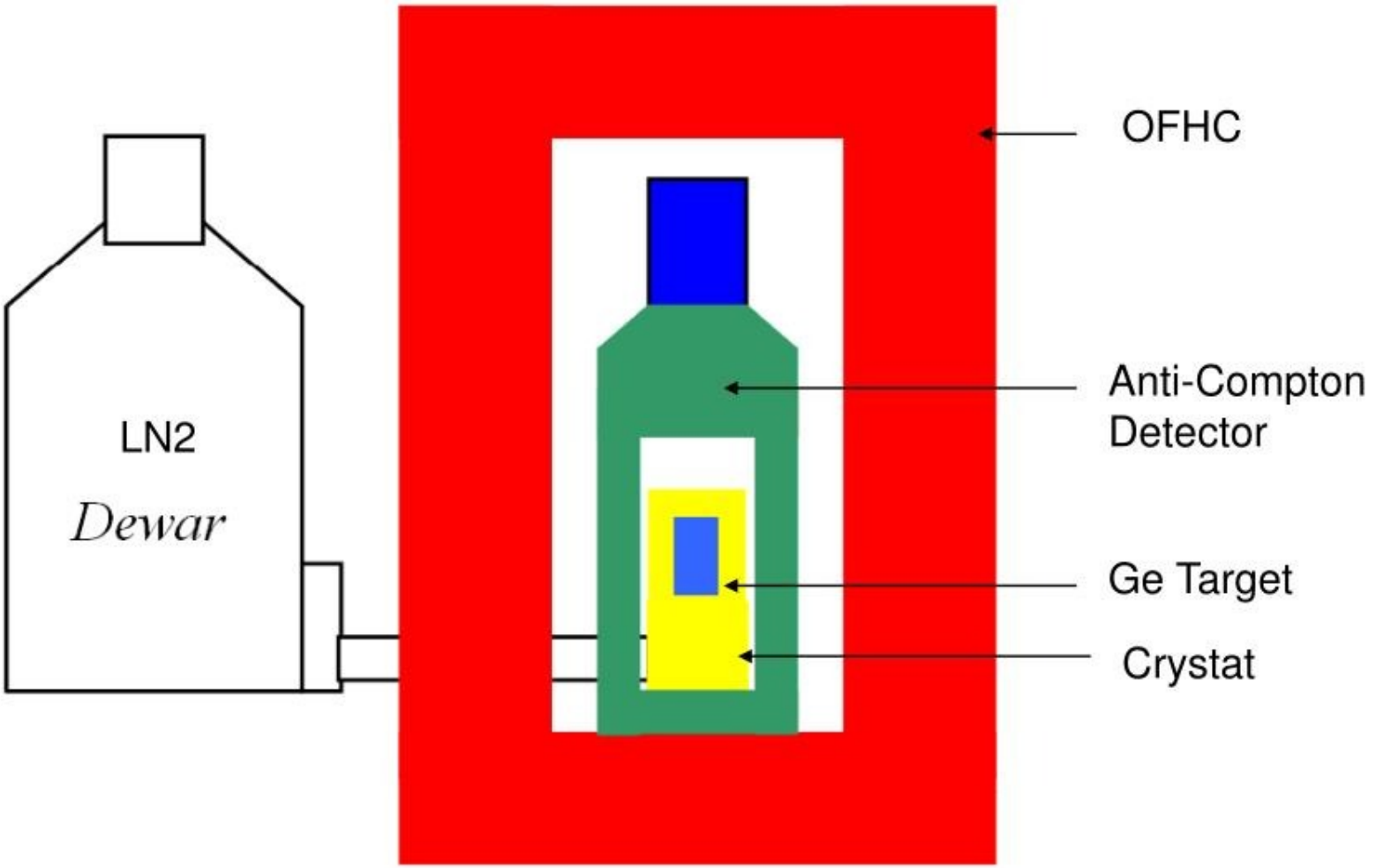
Phase-II (2010.12-2011.12)

-- ULE-HPGe detector(~500g)

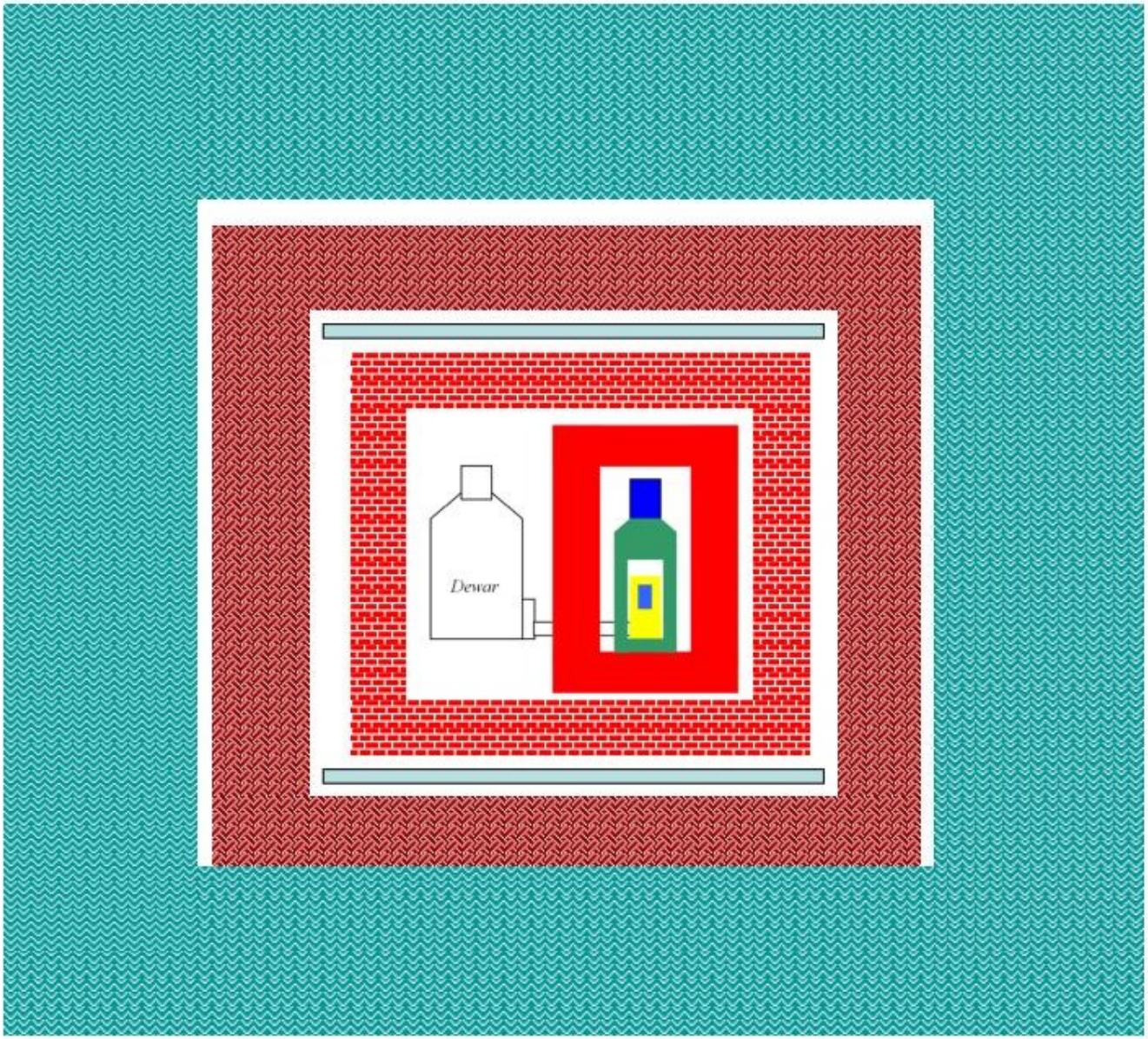
Phase-III (2012-)

-- ULE-HPGe detector(~10kg scale)

Detector and Shielding



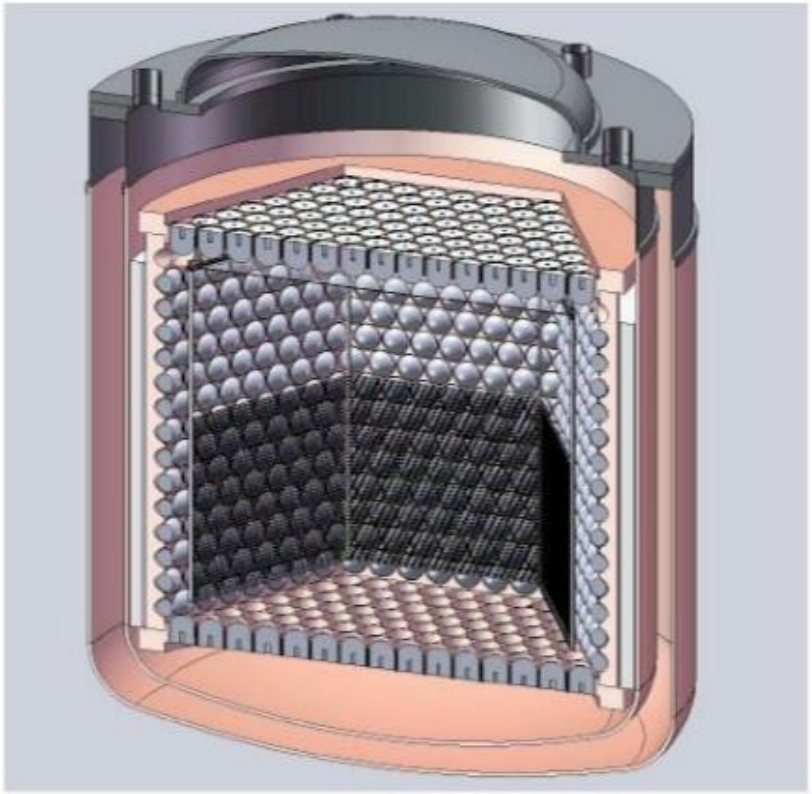
Detector and Shielding



XENONIT: Shanghai Jiaotong Univ.

Collaborating with XENON to develop the next generation dark matter detector based on "two-phase xenon" technique.

- **One ton Xe active mass**
- **1000 PMT**



XENONIT 的设计图
（共需3吨液氙，1000个光电管）

Activities in IHEP

- Major part of the detector team is working for Daya Bay. Good experience for low background experiments.
- Establishing a low background Lab. for the future program of Daya Bay and deep underground experiments.
- R&D on noble liquid detectors Xe and Ar.
- Working on proposal of dark matter search experiment at Jingpin deep underground lab. and look for collaboration.
- Good detector and technical teams.

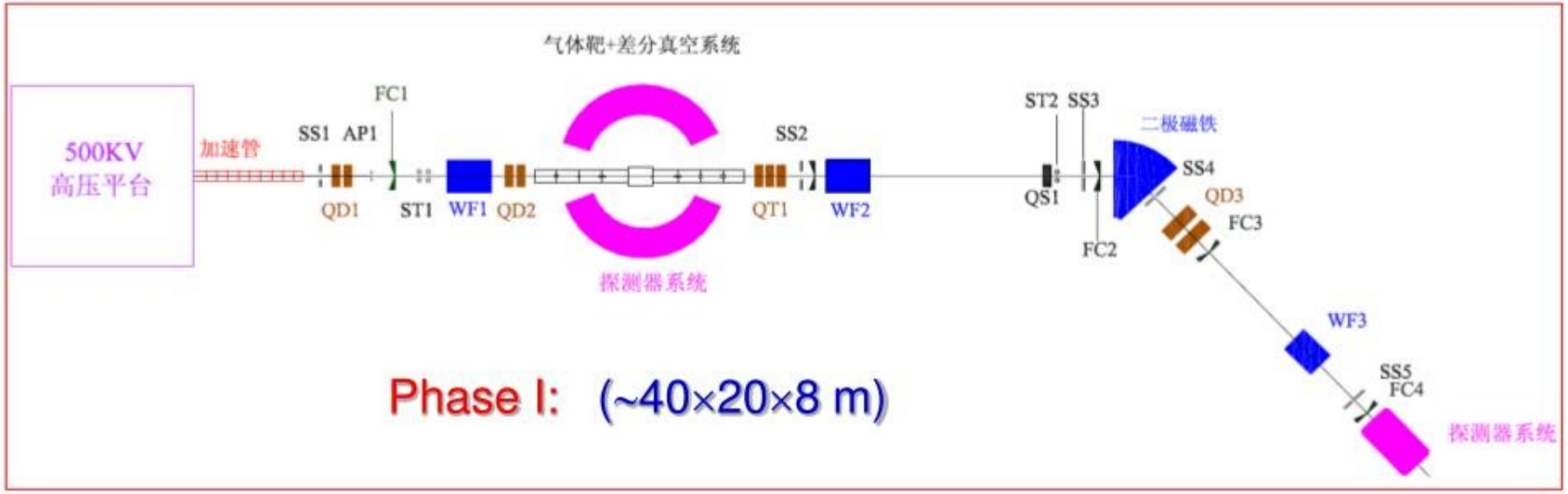
Other R&D Activities

- **R&D on superheated Liquids:**

  Chinese Institute of atomic energy, which has good experience with low background nuclear physics exp..

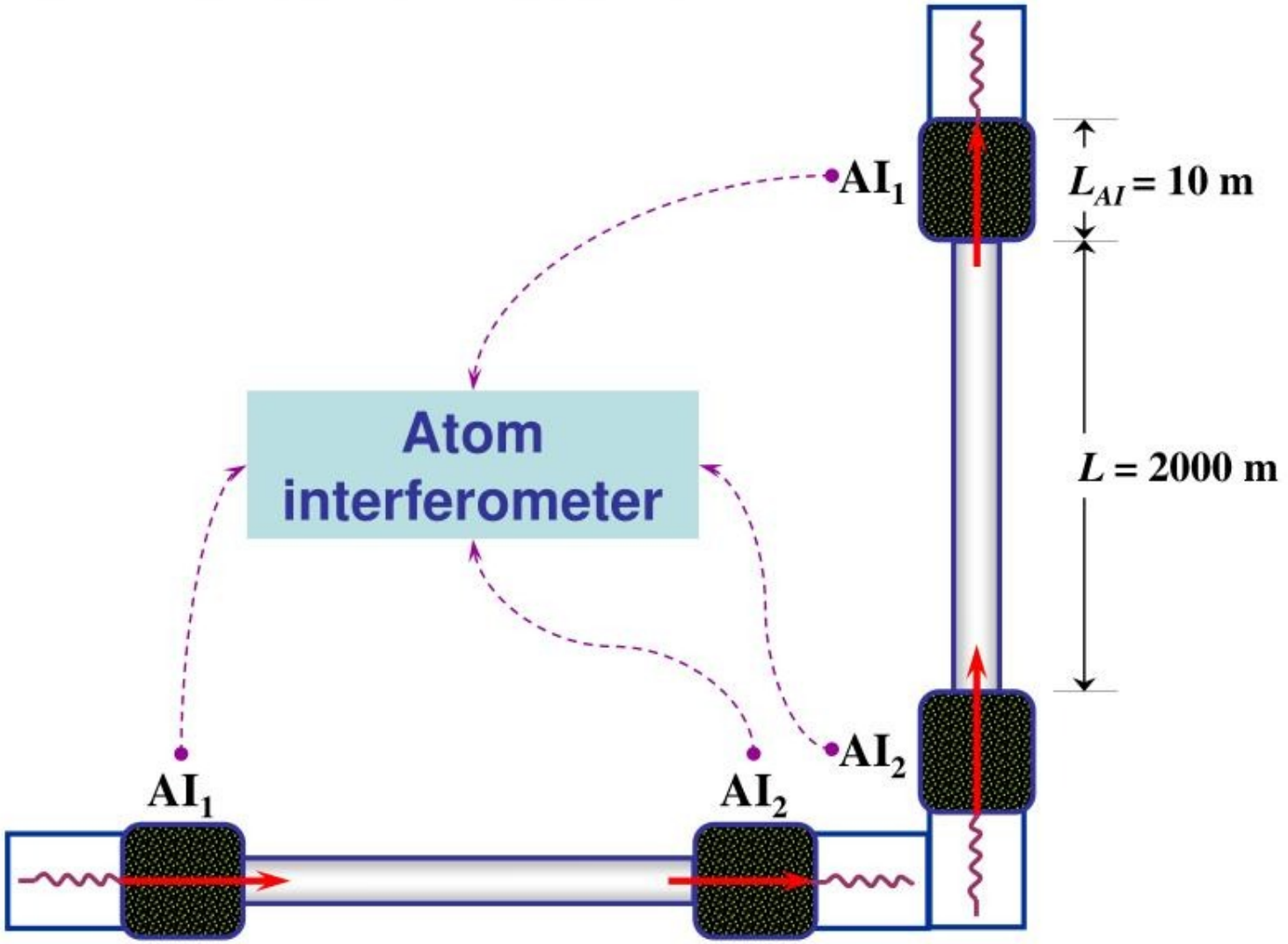
Nuclear Astrophysics: Heavy iron accelerator

- **High voltage Accelerator:**
  - Energy:: 50 - 500 keV (phase I), 5 MeV (phase II)
  - Iron type: p - Fe
  - Current: 1 mA
- **Target system : gas target system**
- **Detectors system**



Gravitation wave detection:

Atom interferometer



Closing Remarks

- The tunnel group at Jingpin mountain provides an unique opportunity to build world deepest deep underground lab with horizontal access for multiple science research.
- Chinese scientific community reached the common understanding to establish China Deep Underground S&E Lab. (CDUSEL)
- Support from owner (EHDC).
- Strategy and Planning agreed. The working group established.
- R&D on dark matter exp.
- Possible first experiments:
  - rock mechanics
  - dark matter search exp.
- International collaboration welcomed.